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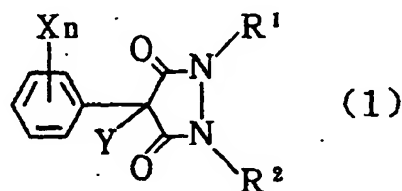
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(57) A 4-aryl-4-substituted pyrazolidine-3,5-dione derivative represented by the formula (1) is useful as an effective component of a miticide, insecticide or herbicide



wherein R¹ and R² are each independently alkyl group having 1 to 4 carbon atoms, or R¹ and R², when taken together, represent saturated or unsaturated bivalent hydrocarbon group having 3 or 4 carbon atoms which may optionally be substituted with alkyl group having 1 to 4 carbon atoms, or halogen atom, X is alkyl group having 1 to 4 carbon atoms, haloalkyl group having 1 to 4 carbon atoms or halogen atom, Y is halogen atom or nitro group, and n is an integer of 0 to 3.

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Description

TECHNICAL FIELD

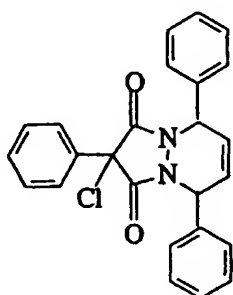
- 5 [0001] The present invention relates to novel 4-aryl-4-substituted pyrazolidine-3,5-dione derivatives and to a miticide, an insecticide or a herbicide each containing the derivative as their active component.

BACKGROUND ART

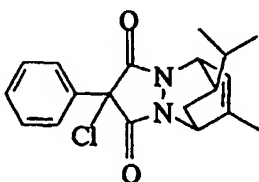
- 10 [0002] Heretofore some kinds of 4-aryl-4-halopyrazolidine-3,5-dione derivatives have been known. For example, An. Quim. vol.71, 396 to 399 (1975) discloses that compounds A, B and C to be described later, i.e. 4-aryl-4-halopyrazolidine-3,5-dione derivatives, can be prepared by Diels-Alder reaction between 4-chloro-4-phenylpyrazolidine-3,5-dione and diene. Further An. Quim. vol.75, 931 to 935 (1979) describes the under-mentioned compounds D and E as an intermediate for preparing 13,14-azasteroid, the compounds being prepared by Diels-Alder reaction between 4-chloro-4-phenylpyrazolidine-3,5-dione and diene. In addition, Comment., Pontif. Acad. Sci. vol.2, 8 (1975) sets forth that compounds A, B and C to be described later can be prepared by chlorination of the corresponding 4-phenylpyrazolidine-3,5-dione derivative.

[0003] However, the compounds of the invention represented by the formula (1) are novel compounds which are not included in conventional compounds.

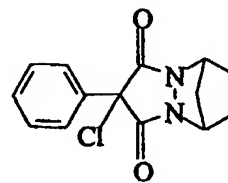
- 20 [0004] On the other hand, 4-aryl-4-nitropyrazolidine-3,5-dione derivatives are entirely novel compounds.



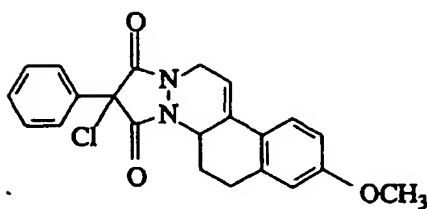
Compound A



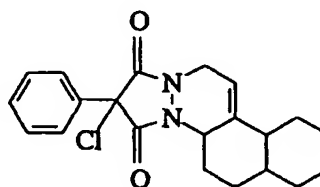
Compound B



Compound C



Compound D



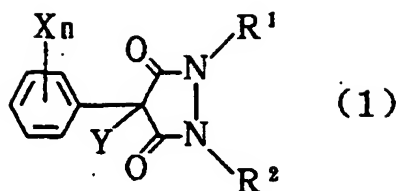
Compound E

- 50 [0005] With insecticides and miticides in use for many years, pest insects have acquired resistance in recent years and become difficult to control with conventional insecticides. Accordingly it is expected to develop novel insecticides. Also in the herbicide field, the development of novel herbicides are expected.

[0006] An object of the present invention is to provide 4-aryl-4-substituted pyrazolidine-3,5-dione derivatives which have not only extremely high insecticidal and miticidal activities but a high herbicidal activity.

55 DISCLOSURE OF THE INVENTION

[0007] The present invention provides a 4-aryl-4-substituted pyrazolidine-3,5-dione derivative represented by the formula (1), a process for preparing the same and a miticide, an insecticide or a herbicide each containing the derivative



wherein R¹ and R² are each independently alkyl group having 1 to 4 carbon atoms, or R¹ and R², when taken together, represent saturated or unsaturated bivalent hydrocarbon group having 3 or 4 carbon atoms which may optionally be substituted with alkyl group having 1 to 4 carbon atoms or halogen atom, X is alkyl group having 1 to 4 carbon atoms, haloalkyl group having 1 to 4 carbon atoms or halogen atom, Y is halogen atom or nitro group, and n is an integer of 0 to 3.

[0008] Examples of alkyl groups having 1 to 4 carbon atoms in the formula (1) are methyl, ethyl, n-propyl, isopropyl, n-butyl, isobutyl, sec-butyl and tert-butyl.

[0009] Examples of haloalkyl groups having 1 to 4 carbon atoms are fluoromethyl, chloromethyl, bromomethyl, iodomethyl, difluoromethyl, trifluoromethyl, 2-fluoroethyl, 2-chloroethyl, 1-fluoroethyl, pentafluoroethyl, 1-fluoropropyl, 2-chloropropyl, 3-fluoropropyl, 3-chloropropyl, 1-fluorobutyl, 1-chlorobutyl and 4-fluorobutyl.

[0010] Halogen atoms include fluorine, chlorine, bromine and iodine atoms.

[0011] Saturated or unsaturated divalent hydrocarbon groups having 3 or 4 carbon atoms include trimethylene, tetramethylene and propenylene groups.

[0012] The compounds of the present invention exhibit a high effect against various harmful organisms even when used at a low dose. These harmful organisms include, for example, the following agricultural harmful insects:

those of the order *Tetranychus*, e.g. spider mites such as *Tetranychus urticae*, *Panonychus citri*, *Panonychus ulmi*, *Tetranychus kanzawai*, etc. and *Tarsonemidae* such as *Polyphagotarsonemus latus*;

those of the order *Hemiptera*, e.g. planthoppers such as *Laodelphax striatellus* and *Nilaparvata lugens*, leafhoppers such as *Nephotettix cincticeps* and *Arboridia apicalis*, aphides such as *Myzus persicae*, *Aphis gossypii* and *Ovatus malicollens*, shield-bugs, scales and whiteflies;

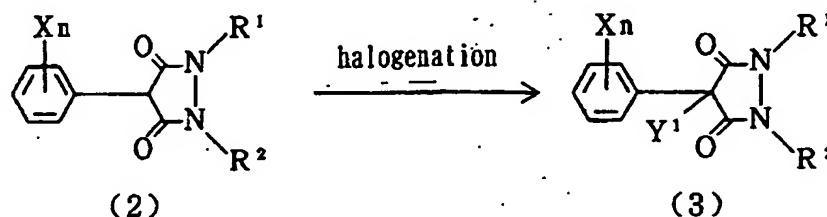
those of the order *Thysanoptera* such as *Scirtothrips dorsalis*, *Thrips palmi*, *Frankliniella occidentalis* and *Frankliniella intonsa*; and

those of the order *Diptera* such as *Phytobia cepae* HERING and *Liriomyza trifolii*.

[0013] The compounds of the present invention have an activity against sanitary insect pests such as *Culex pipiens pallens*, *Musca domestica* and other insect pests as well as against agricultural harmful insects.

[0014] At a low dose, the compounds of the present invention can control weeds such as chickweed, *Digitaria adscendens*, *Monochoria vaginalis* var. *plantaginea*, *Echinochloa Crus-galli*, *Cyperus microiria* Steud. and *Cyperus serotinus* Rottb. which pose agricultural problems. The effectiveness of the compounds is specifically demonstrated in Test Examples on organisms to be described later.

[0015] Among the compounds of the present invention represented by the formula (1), a compound of the present invention represented by the formula (3) can be prepared according to the following reaction scheme



wherein R¹, R², X and n are as defined above and Y¹ is halogen atom.

[0016] According to the reaction scheme illustrated above, 4-arylpyrazolidine-3,5-dione derivative represented by the formula (2) is reacted with a halogenating agent in an inert solvent to give a compound of the invention represented

by the formula (3).

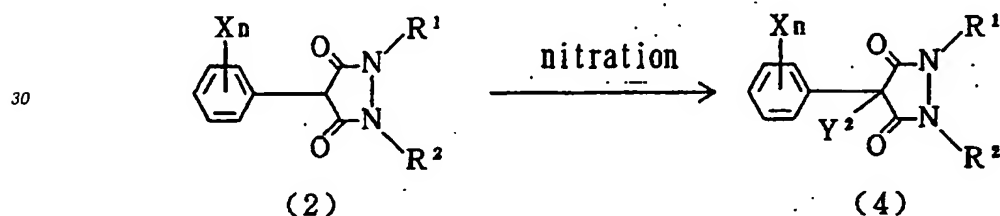
[0017] The 4-arylpyrazolidine-3,5-dione derivative of the formula (2) can be prepared according to the method disclosed in JP-(PCT)-6-506201.

[0018] Examples of the halogenating agent used in halogenation are inorganic halides such as chlorine, thionyl chloride, sulfuryl chloride, phosgene, phosphorus trichloride, phosphorus pentachloride, bromine, thionyl bromide, sulfuryl bromide, phosphorus pentabromide and phosphorus oxybromide, organic halides such as N-chlorosuccinic acid imide (NCS) and N-bromosuccinic acid imide (NBS), alkali metal salts of hypochloric acid such as sodium hypochlorite, organic hypochlorine oxides such as tert-butyl hypochlorite. The amount of the halogenating agent used in the reaction is 1 to 10 equivalents, preferably 1 to 4 equivalents, per equivalent of the 4-arylpyrazolidine-3,5-dione derivative of the formula (2).

[0019] Examples of the solvent used in halogenation are halogenated hydrocarbons such as methylene chloride, 1,2-dichloroethane and carbon tetrachloride; aromatic hydrocarbons such as benzene, toluene, xylene and o-chlorobenzene; and ethers such as diethyl ether, tetrahydrofuran and 1,4-dioxane. The reaction temperature, although not specifically limited, is in the range of usually -30°C to the boiling point of the solvent used. It is possible to carry out the reaction at a temperature in the range of from 0°C to the reflux temperature of the halogenating agent without use of the solvent. Although variable depending on the above-mentioned concentration, temperature and other factors, the reaction time is in the range of about 0.1 to about 6 hours. Optionally the reaction may be conducted in the presence of a catalyst. Examples of useful catalysts are benzoyl peroxide (BPO), 2,2'-azobisisobutyronitrile (AIBN), 4,4'-azobis-4-cyanovaleric acid (ACVA) and like radical initiators. The amount of the catalyst used is 0.00001 to 1 equivalent, preferably 0.0001 to 0.1 equivalent, per equivalent of the compound of the formula (3).

[0020] The 4-aryl-4-halopyrazolidine-3,5-dione derivative of the invention having the formula (3) can be purified by conventional methods such as solvent extraction, recrystallization and chromatographies such as column chromatography and preparative thin layer chromatography.

[0021] Among the compounds of the invention represented by the formula (1), a compound of the invention represented by the formula (4) can be prepared according to the following reaction scheme



wherein R^1 , R^2 , X and n are as defined above and Y^2 is nitro group.

[0022] According to the reaction scheme illustrated above, 4-arylpyrazolidine-3,5-dione derivative of the formula (2) is reacted with a nitrating agent in a solvent to give a compound of the invention represented by the formula (4).

[0023] Examples of the nitrating agent used herein are mixed acids, nitric acid, fuming nitric acid, and alkali metal salts of nitric acid such as potassium nitrate. The amount of the nitrating agent used in the reaction is 1 to 10 equivalents, preferably 1 to 2 equivalents, per equivalent of the 4-arylpyrazolidine-3,5-dione derivative of the formula (2). Examples of the solvent used in nitration include not only concentrated sulfuric acid useful as a component of mixed acids but also halogenated hydrocarbons such as methylene chloride and 1,2-dichloroethane, and acid anhydrides such as acetic anhydride. The reaction temperature, although not specifically limited, is in the range of 0°C to the boiling point of the solvent used. Although variable depending on the above-mentioned concentration, temperature and other factors, the reaction time is usually in the range of about 0.1 to about 6 hours.

[0024] The 4-aryl-4-nitropyrazolidine-3,5-dione derivative of the formula (4) can be purified by conventional methods such as solvent extraction, recrystallization and chromatographies such as column chromatography and preparative thin layer chromatography.

[0025] Although the compound of the invention is usable as it is when used as an active component for an insecticide, a miticide or a herbicide, the compound of the invention is usually used as mixed with a solid carrier, liquid carrier or gas carrier, optionally together with a surfactant and other adjuvants useful for such formulations. The compound of the invention is provided in the form of oil formulation, emulsifiable concentrate, wettable powder, flowables, granules, dusts, aerosols or fumigants.

[0026] The compound of the invention is used in an amount of 0.01 to 95% by weight as contained in these formulations as their active component.

[0027] Examples of solid carriers useful in preparing the formulations are clays including kaolin clay, diatomite,

water-containing synthetic silicon oxide, bentonite, Fubasami clay, and acid clay; talcs; ceramics; inorganic minerals such as Celite, quartz, sulfur, active carbon, calcium carbonate and hydrated silica; and chemical fertilizers such as ammonium sulfate, ammonium phosphate, ammonium nitrate, urea and ammonium chloride, these solid carriers being finely divided or granular. Examples of useful liquid carriers are water, alcohols such as methanol and ethanol, ketones such as acetone and methyl ethyl ketone, aromatic hydrocarbons such as benzene, toluene, xylene, ethylbenzene and methylnaphthalene, aliphatic hydrocarbons such as hexane, cyclohexane, kerosene and light oil, esters such as ethyl acetate and butyl acetate, nitriles such as acetonitrile and isobutyronitrile, ethers such as diisopropyl and dioxane, acid amides such as N,N-dimethylformamide and N,N-dimethylacetamide, halogenated hydrocarbons such as dichloromethane, trichloroethane and carbon tetrachloride, dimethyl sulfoxide, and vegetable oils such as soybean oil and cotton-seed oil. Examples of gas carriers, i.e., those of propellants, are butane gas, LPG (liquefied natural gas), dimethyl ether and carbon dioxide gas.

[0028] Examples of surfactants are alkylsulfuric acid esters, alkylsulfonic acid salts, alkylarylsulfonic acid salts, alkyl aryl ethers and polyoxyethylene adducts thereof, polyethylene glycol ethers, polyhydric alcohol esters and sugar alcohol derivatives.

[0029] Examples of adjuvants for the formulations, such as binders and dispersants, are casein, gelatin, polysaccharides such as starch, gum arabic, cellulose derivatives and alginic acid, lignin derivatives, bentonite, sugars and water-soluble synthetic high-molecular-weight substances such as polyvinyl alcohol, polyvinyl pyrrolidone and polyacrylic acids. Examples of stabilizers are PAP (acid isopropyl phosphate), BHT (2,6-di-tert-butyl-4-methylphenol), BHA (mixture of 2-tert-butyl-4-methoxyphenol and 3-tert-butyl-4-methoxyphenol), vegetable oils, mineral oils, surfactants and fatty acids or esters thereof.

[0030] The formulation thus obtained can be used as it is or as diluted, for example, with water. The formulation is usable also as admixed with other insecticides, nematocides, acaricides, fungicides, herbicides, plant growth regulators, synergists, soil improvers, baits and the like, or is usable simultaneously with such agents without mixing.

[0031] When used as an agricultural insecticide, a miticide or a herbicide, the compound of the invention is preferably applied usually in an amount of 0.01 to 500 g/100 m². When an emulsifiable concentrate, wettable powder or flowables are used as diluted with water, the compound is applied usually at a concentration of 0.1 to 1000 ppm, preferably 1 to 500 ppm. The granular or dust can be applied as it is without dilution.

[0032] The amount or concentration of application, although exemplified above, can be suitably increased or reduced according to the type of preparation, time, place, method of application, kind of pest insects, kind of weeds and extent of harm suffered.

BEST MODE OF CARRYING OUT THE INVENTION

[0033] The present invention will be described in detail with reference to the following preparation examples, formulation examples and test examples to which the invention, however, is not limited. First, preparation examples are given for the compounds of the invention. In Tables, Me stands for methyl; Et for ethyl and iPr for isopropyl.

Preparation Example 1

Preparation of 4-chloro-1,2-dimethyl-4-(2,4,6-trimethylphenyl)pyrazolidine-3,5-dione (compound 19 of the invention)

[0034] There was refluxed with heating a mixture of 0.50 g (2.0 mmols) of 1,2-dimethyl-4-(2,4,6-trimethylphenyl)pyrazolidine-3,5-dione, 0.32 g (2.4 mmols) of N-chlorosuccinic acid imide, 19 mg (0.08 mmol) of benzoyl peroxide and 20 ml of carbon tetrachloride for 30 minutes. Water was added to the reaction mixture, followed by extraction with chloroform. The extract was washed with an aqueous solution of saturated sodium hydrogencarbonate and a saturated solution of sodium chloride and was dried over anhydrous magnesium sulfate. The solvent was distilled off under reduced pressure. Then the residue was washed with hexane, thereby obtaining 0.44 g (yield 78%) of 4-chloro-1,2-dimethyl-4-(2,4,6-trimethylphenyl)pyrazolidine-3,5-dione in the form of yellowish white crystals.

Preparation Example 2

Preparation of 4-chloro-4-(2-chlorophenyl)-1,2-dimethylpyrazolidine-3,5-dione (compound 3 of the invention)

[0035] A chloroform solution (5 ml) of 0.28 g (2.1 mmols) of sulfuryl chloride was added dropwise to a solution of 0.50 g (2.1 mmols) of 4-(2-chlorophenyl)-1,2-dimethylpyrazolidine-3,5-dione in 10 ml of chloroform with ice cooling. The mixture was stirred with ice cooling for 30 minutes. The reaction mixture was washed successively with water, an aqueous solution of saturated sodium hydrogencarbonate and a saturated solution of sodium chloride and was dried over anhydrous magnesium sulfate. The solvent was distilled off under reduced pressure. Then the residue was washed with

hexane, thereby obtaining 0.43 g (yield 74%) of 4-chloro-1,2-dimethyl-4-(2-chlorophenyl)pyrazolidine-3,5-dione in the form of yellowish white crystals.

Preparation Example 3

Preparation of 4-bromo-4-(2-chlorophenyl)-1,2-dimethylpyrazoline-3,5-dione (compound 21 of the invention)

[0036] A chloroform solution (5 ml) of 0.33 g (2.1 mmols) of bromine was added dropwise to a solution of 0.50 g (2.1 mmols) of 1,2-dimethyl-4-(2-chlorophenyl)pyrazolidine-3,5-dione in 10 ml of chloroform with ice cooling. The obtained mixture was stirred with ice cooling for 30 minutes. The reaction mixture was washed successively with water; an aqueous solution of saturated sodium hydrogencarbonate and a saturated solution of sodium chloride and was dried over anhydrous magnesium sulfate. The solvent was distilled off under reduced pressure. Then the residue was washed with hexane, thereby obtaining 0.50 g (yield 75%) of 4-bromo-4-(2-chlorophenyl)-1,2-dimethylpyrazoline-3,5-dione in the form of yellow crystals.

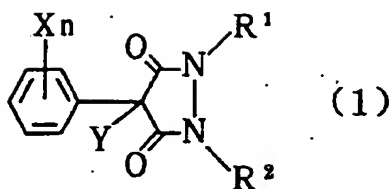
Preparation Example 4

Preparation of 1,2-dimethyl-4-nitro-4-(2,4,6-trimethylphenyl)pyrazolidine-3,5-dione (compound 36 of the invention)

[0037] A quantity of 0.13 ml (3.1 mmols) of fuming nitric acid was added to a solution of 0.70 g (2.8 mmols) of 1,2-dimethyl-4-(2,4,6-trimethylphenyl)pyrazolidine-3,5-dione in 20 ml of chloroform at room temperature. The obtained mixture was stirred at room temperature for 15 minutes. The reaction mixture was washed with water and was dried over anhydrous magnesium sulfate. The solvent was distilled off under reduced pressure. Then the residue was purified by column chromatography (benzene : ethyl acetate = 3 : 1) to give 0.53 g (yield 64%) of 1,2-dimethyl-4-nitro-4-(2,4,6-trimethylphenyl)pyrazolidine-3,5-dione in the form of yellowish white crystals.

[0038] Tables 1 to 6 show the compounds prepared by any of the processes described in the Preparation Examples given above and the physicochemical properties of the compounds.

Table 1



Compound	Xn	Y	R ¹	R ²	mp (°C)
1	-	Cl	Me	Me	93 ~ 94
2	2-F	Cl	Me	Me	144 ~ 147
3	2-Cl	Cl	Me	Me	192 ~ 193
4	2-Cl	Cl	Me	Et	110 ~ 112
5	2-Cl	Cl	Me	iPr	126 ~ 127
6	2-Cl	Cl	Et	Et	129 ~ 130
7	3-Cl	Cl	Me	Me	73 ~ 74
8	4-Cl	Cl	Me	Me	178 ~ 179
9	2-Br	Cl	Me	Me	197 ~ 198
10	2-Me	Cl	Me	Me	168 ~ 169
11	2-CF ₃	Cl	Me	Me	131 ~ 132
12	2,3-Cl ₂	Cl	Me	Me	157 ~ 158
13	2,4-Cl ₂	Cl	Me	Me	176 ~ 177
14	2,5-Cl ₂	Cl	Me	Me	143 ~ 144
15	2,6-Cl ₂	Cl	Me	Me	147 ~ 148
16	3,4-Cl ₂	Cl	Me	Me	120 ~ 121
17	3,5-Cl ₂	Cl	Me	Me	127 ~ 128
18	2,4,6-Cl ₃	Cl	Me	Me	185 ~ 186

Table 2

Compound	Xn	Y	R ¹	R ²	mp (°C)
19	2,4,6-Me ₃	Cl	Me	Me	98 ~ 100
20	-	Br	Me	Me	100 ~ 101
21	2-Cl	Br	Me	Me	198 ~ 199
22	2-Cl	Br	Et	Et	143 ~ 144
23	4-Cl	Br	Me	Me	185 ~ 186
24	2-Me	Br	Me	Me	176 ~ 177
25	2,3-Cl ₂	Br	Me	Me	178 ~ 179
26	2,4-Cl ₂	Br	Me	Me	174 ~ 175
27	2,6-Cl ₂	Br	Me	Me	138 ~ 139
28	2,5-Cl ₂	Br	Me	Me	178 ~ 179
29	3,4-Cl ₂	Br	Me	Me	124 ~ 125
30	3,5-Cl ₂	Br	Me	Me	119 ~ 120
31	2,4,6-Me ₃	Br	Me	Me	101 ~ 103
32	2-Cl	NO ₂	Me	Me	118 ~ 119
33	2-Cl	NO ₂	Et	Et	109 ~ 110
34	4-Cl	NO ₂	Me	Me	123 ~ 124
35	2-Me	NO ₂	Me	Me	106 ~ 107
36	2,4-Cl ₂	NO ₂	Me	Me	130 ~ 131
37	2,4,6-Me ₃	NO ₂	Me	Me	136 ~ 137

Table 3

Compound	¹ H-NMR δ (ppm, CDCl ₃)
1	3.33(s,6H), 7.35(m, 3H), 7.62~7.70(m, 2H)
2	3.36(s, 6H), 7.31(dd, 1H), 7.35~7.45(m, 1H), 7.50(dd, 1H), 7.87(dt, 1H)
3	3.37(s, 6H), 7.32~7.47(m, 3H), 8.01(dd, 1H)
4	1.32(t, 3H), 3.34(s,3H), 3.58~3.70(m, 1H), 3.97~4.10(m, 1H), 7.35~7.45(m, 3H), 8.02(dd, 1H)
5	1.47~1.68(m, 6H), 3.38(s, 3H), 4.34~4.50(m, 1H), 7.35~7.45(m, 3H), 8.00(dt, 1H)
6	1.31(t, 6H), 3.70~3.95(m, 4H), 7.36~7.49(m, 3H), 8.02(d, 1H)
7	3.34(s, 6H), 7.30~7.40(m, 2H), 7.60~7.65(m, 1H), 7.70(m, 1H)
8	3.34(s, 6H), 7.39(d, 2H), 7.68(d, 2H),
9	3.39(s, 6H), 7.31(dt, 1H), 7.49(dt, 1H), 7.57(dd, 1H), 8.04(dt, 1H)
10	2.19(s, 3H), 3.38(s, 6H), 7.16(dd, 1H) 7.28~7.36(m, 2H), 7.86(dd, 1H)
11	3.35(s, 6H), 7.58(t, 1H), 7.68~7.78(m, 2H), 8.31(d, 1H)
12	3.38(s, 6H), 7.39(t, 1H), 7.56(dd, 1H), 7.96(dd, 1H)
13	3.37(s, 6H), 7.38~7.45(m, 2H), 7.95(d, 1H)

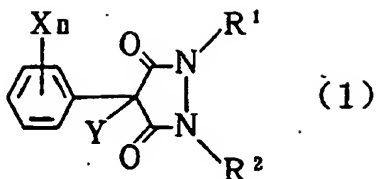
Table 3 (continued)

Compound	¹ H-NMR δ (ppm, CDCl ₃)
14	3.37(s, 6H), 7.31(d, 1H), 7.37(dd, 1H) 8.00(d, 1H)
15	3.35(s, 6H), 7.23(d, 1H), 7.38(d, 2H)
16	3.35(s, 6H), 7.49(d, 1H), 7.61(dd, 1H) 7.83(d, 1H)
17	3.36(s, 6H), 7.40(d, 1H), 7.63(d, 2H)
18	3.35(s, 6H), 7.41(s, 2H)

Table 4

Compound	¹ H-NMR δ (ppm, CDCl ₃)
19	2.23(s, 3H), 2.43(s, 6H), 3.35(s, 6H), 6.85(s, 2H)
20	3.32(s, 6H), 7.32~7.42(m, 3H), 7.80~7.85(m, 2H)
21	3.37(s, 6H), 7.30~7.40(m, 3H), 8.06(dd, 1H)
22	1.31(t, 6H), 3.72~3.95(m, 4H), 7.32~7.45(m, 3H) 8.05~8.12(m, 1H)
23	3.33(s, 6H), 7.37(d, 2H), 7.84(d, 2H)
24	2.16(s, 3H), 3.37(s, 6H), 7.11~7.15(m, 1H), 7.27~7.36(m, 3H), 7.89~7.93(m, 1H)
25	3.38(s, 6H), 7.36(t, 1H), 7.56(dd, 1H), 8.00(dd, 1H)
26	3.36(s, 6H), 7.35~7.40(m, 2H), 7.99(d, 1H)
27	3.35(s, 6H), 7.22(d, 1H), 7.78(d, 2H)
28	3.37(s, 6H), 7.29(d, 1H), 7.35(dd, 1H), 8.05(d, 1H)
29	3.33(s, 6H), 7.47(d, 1H), 7.78(dd, 1H), 8.00(d, 1H)
30	3.34(s, 6H), 7.38(d, 1H), 7.80(d, 2H)
31	2.23(s, 3H), 2.43(s, 6H), 3.34(s, 6H), 6.85(s, 2H)
32	3.36(s, 6H), 7.26(d, 1H), 7.33~7.50(m, 3H)
33	1.25(t, 6H), 3.70~3.90(m, 4H), 7.24(dd, 1H), 7.36(dt, 1H), 7.44(dt, 1H), 7.51(dd, 1H)
34	3.38(s, 6H), 7.46(d, 2H), 7.87(d, 2H)
35	2.48(s, 3H), 3.37(s, 6H), 7.12~7.40(m, 4H)
36	3.40(s, 6H), 7.22(d, 1H), 7.36(dd, 2H), 7.52(d, 1H)
37	2.25(s, 6H), 2.26(s, 3H), 3.39(s, 6H), 6.90(s, 2H)

Table 5



Compound	Xn	Y	-R ¹ -R ² -	mp (°C)
38	2-Cl	Cl	-(CH ₂) ₃ -	228~229
39a	2-Cl	Cl	-CH(Me)CH ₂ CH ₂ -	209~210
*				
39b	2-Cl	Cl	-CH(Me)CH ₂ CH ₂ -	208~209
*				
40	2-Cl	Cl	-(CH ₂) ₄ -	167~168
41	2-Cl	Cl	-CH(Me)CH ₂ CH ₂ CH ₂ -	128~130
42	2-Cl	Cl	-CH=CHCH ₂ CH ₂ -	135~137
43	2,4,6-Me ₃	Cl	-(CH ₂) ₄ -	132~133
44	2-Cl	NO ₂	-(CH ₂) ₄ -	148~149
45	2-Cl	Cl	-CHClCHClCH ₂ CH ₂ -	148~149

(Note) Compound 39a is a compound wherein a diastereomer has a higher R_f value in thin layer chromatography on silica gel (25 TLC plastic sheets 20 × 20 cm, silica gel 60F₂₅₄, Merck/eluent: hexane/ethyl acetate =1/1), and Compound 39b is a compound wherein a diastereomer has a lower R_f value in said chromatography.

Table 6

Compound	¹ H-NMR δ (ppm, CDCl ₃)
38	2.40~2.53(m, 2H), 3.60~3.74(m, 2H), 4.08~4.18(m, 2H), 7.36~7.48(m, 3H), 7.99(dd, 1H)
39a	1.52(d, 3H), 2.12~2.22(m, 1H), 2.52~2.66(m, 1H), 3.69~3.79(m, 1H), 4.00~4.08(m, 1H) 4.37~4.48(m, 1H), 7.33~7.47(m, 3H), 7.98(dd, 1H)
39b	1.62(d, 3H), 2.16~2.27(m, 1H), 2.64~2.75(m, 1H), 3.74~3.85(m, 1H), 3.90~4.00(m, 1H) 4.25~4.38(m, 1H), 7.35~7.45(m, 3H), 8.08(dd, 1H)
40	1.80~1.95(m, 4H), 3.65~3.80(m, 4H), 7.35~7.48(m, 3H), 8.02(dd, 1H)
41	1.35~1.48(m, 3H), 1.70~2.10(m, 4H), 3.12~3.46(m, 1H), 4.12~4.27(m, 1H) 4.42~4.65(m, 1H), 7.35~7.45(m, 3H), 8.01(d, 1H)
42	2.40~2.67(m, 2H), 3.69(ddd, 1H), 4.25(ddd, 1H), 5.37~5.44(m, 1H), 7.15(d, 1H), 7.35~7.50(m, 3H) 8.03(d, 1H)
43	1.80~1.95(m, 4H), 2.23(s, 3H), 2.44(s, 6H),
44	1.78~2.00(m, 4H), 3.65~3.85(m, 4H), 7.27~7.50(m, 4H) 4.38(ddd, 1H), 4.56(dd, 1H), 6.37(s, 1H), 7.37~7.50(m, 3H), 7.95~8.0(m, 1H)

[0039] Formulation Examples are given below wherein the parts are by weight.

25 Formulation Example 1 (Emulsifiable concentrate)

[0040] Ten parts of each compound of the invention was dissolved in 45 parts of Solvesso 150 and 35 parts of N-Methylpyrrolidone. Ten parts of Sorpol 3005X (emulsifier manufactured by Toho Kagaku Co., Ltd.) was added. These ingredients were mixed together with stirring to give a 10% emulsifiable concentrate.

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Formulation Example 2 (Wettable powder)

[0041] Twenty parts of each compound of the invention was added to a mixture of 2 parts of sodium lauryl sulfate, 4 parts of sodium lignin sulfonate, 20 parts of finely divided water-containing synthetic silicon oxide and 54 parts of clay. These ingredients were mixed together with stirring by a juice mixer to give a 20% wettable powder.

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Formulation Example 3 (Granules)

[0042] Each compound of the invention (5 parts) was mixed with 2 parts of sodium dodecylbenzene sulfonate, 10 parts of bentonite and 83 parts of clay, followed by thorough agitation. A suitable amount of water was added to the mixture and further stirred. The mixture was granulated by a granulator and air-dried to give 5% granules.

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Formulation Example 4 (Dust)

[0043] Each compound of the invention (1 part) was dissolved in a suitable amount of acetone. To the solution were added 5 parts of finely divided water-containing synthetic silicon oxide, 0.3 part of acid isopropyl phosphate (PAP) and 93.7 parts of clay. The ingredients were mixed together with stirring by a juice mixer and the acetone was removed by evaporation to give a 1% dust formulation.

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50 Formulation Example 5 (Flowables)

[0044] Each compound of the invention (20 parts) was mixed with 20 parts of water containing 3 parts of polyoxyethylene tristyrylphenyl ether phosphoric acid ester triethanolamine and 0.2 part of Roadazyl 426 R (silicon-type deforming agent). The mixture was pulverized by wet method using a dynamill. Thereafter the mixture was mixed with 60 part of water containing 8 parts of propylene glycol and 0.32 part of xanthane gum to give a 20% suspension in water.

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[0045] Test Examples are given below to show that the compounds of the invention are useful as an active agent for a miticide, insecticide and herbicide.

Test Example 1

Insecticidal test on *Tetranychus uricae*

- 5 [0046] Leaves of kidney bean plants (about 3.5 × 4.5 cm) were placed on non-woven fabric pieces (4.5 × 5.5 cm) containing sufficient water. Then, about 30 female adult insects of *Tetranychus uricae* were released on the leaves to stay on the leaves, which were then placed in a thermostatic chamber at a temperature of 25 ± 2°C and a humidity of 40%. An insecticidal formulation (200 ppm) was prepared by adding an aqueous solution (100 ppm) of Sorpol 355 (product of Toho Kagaku Co., Ltd.) to a methanol solution of a compound of the invention. Subsequently the formulation
- 10 (2.0 ml) was sprayed over the leaves, and was air-dried. The leaves were left to stand in the thermostatic chamber (25 ± 2°C, humidity 50%) for 2 days. Then a mortality of *Tetranychus uricae* was checked.
- [0047] A mortality of more than 50% is ascribed to the following compounds of the invention: compounds 3, 5, 9, 10 13, 14, 15, 18, 19, 21, 24, 26, 27, 28, 31, 35, 37, 38, 39a, 39b, 41 and 43.

15 Test Example 2

Insecticidal test on *Myzus persicae*

- [0048] Leaves of cabbage plants in 2-leaf stage (2 cm in diameter) were placed on non-woven fabric pieces containing sufficient water. About 30 larvae of *Myzus persicae* were released on the leaves to stay on the leaves, which were then placed in a thermostatic chamber (25 ± 2°C, humidity 50%). Next day, the insecticidal formulation (200 ppm) described in Test Example 1 was sprayed over the leaves and was air-dried. The leaves were left to stand in the thermostatic chamber for 3 days. Then a mortality of *Myzus persicae* was assessed.
- [0049] A mortality of more than 50% is ascribed to the following compounds of the invention:
- 25 compounds 15, 18, 19, 31, 37 and 43.

Test Example 3

Insecticidal test on *Laodelphax striatellus*

- 30 [0050] 2.5 ml of the insecticidal formulation (conc. 200 ppm) described in Test Example 1 was applied dropwise to the surface of soil in pots (3 × 4 × 4 cm) having planted therein paddy rice seedlings. After the formulation was permeated into the soil, 30 third instar larvae of *Laodelphax striatellus* were released into the pots. Then the pots were left to stand in a thermostatic chamber (25 ± 2°C, humidity 50%) . After 7 days, a mortality of *Laodelphax striatellus* was checked.
- 35 [0051] A mortality of more than 50% is ascribed to the following compounds of the invention: Compounds 3, 4, 5, 9, 10, 13, 15, 18, 19, 21, 26, 27, 31, 32, 37 and 43.

Test Example 4 Test for herbicidal activity (soil treatment test and stem- and leaf-treatment test)

- 40 [0052] A specified amount of the compound of the invention was dissolved in a small amount of acetone. Then the solution was diluted with an aqueous solution of Tween 80 to give a herbicidal formulation (2000 ppm). Pots (square, 5 cm in each side) were filled with paddy soil and a suitable quantity of seeds of chickweed, *Aeschynomene indica*, *Echinochloa Crus-galli* and *Digitaria adscendens* were sown in the pots. The pots were then covered with a thin layer of soil.
- 45 In the soil treatment, the herbicidal formulation was uniformly applied dropwise over the soil surface immediately after sowing the seeds. In the stem- and leaf-treatment, the herbicidal formulation was sprayed over the soil after 8-day growth of the plants at room temperature of 23°C in a 16-hour lighting chamber. The herbicidal formulation was applied in an amount of 4 kg/ha calculated as the active component and was used in an amount of 0.5 ml both in the soil treatment and in the stem- and leaf-treatment. The pots for soil treatment was accommodated in a chamber maintained at
- 50 23°C. The pots for stem- and leaf-treatment were transferred to the glass green house. After 14-day growth under this condition, the herbicidal activity was evaluated according to 6-grade criteria; 0 (inactivity), 10, 20, 30, 40 and 50 (complete withering). The results are shown in Tables 7 and 8.

Table 7

Compd.	amount (kg/ha)	soil treatment			
		chickweed	aeschynomene indica	digitaria	Echinochloa Crus-galli
19	4	50	30	50	50
27	4	50	10	50	50
31	4	50	40	50	50

Table 8

Compd.	Amount (kg/ha)	stem-and leaf-treatment			
		chickweed	Aeschynomene indica	digitaria	Echinochloa Crus-galli
19	4	40	10	40	50
27	4	30	10	40	50
31	4	50	40	50	50

Test Example 5 Test for herbicidal activity (treatment under submerged condition)

[0053] Pots (8 cm in diameter) were filled with paddy soil. Water was poured into the pots to create a submerged condition. Next day, seeds of Echinochloa Crus-galli, Cyperus microiria Steud. and Monochoria vaginalis var. plantaginea were sown and the roots of Cyperus serotinus Rottb. were buried in the soil, followed by treatment with the herbicidal formulation prepared in Test Example 4. One ml of the herbicidal formulation was applied dropwise to the surface of water in the pots under submerged condition. The specified amount of the herbicidal formulation is 4 kg/ha calculated as the active component. After 14-day growth of plants in the glass green house following the treatment, the herbicidal activity was evaluated according to 6-grade criteria; 0 (inactivity), 10, 20, 30, 40 and 50 (complete withering). The results are shown in Table 9.

Table 9

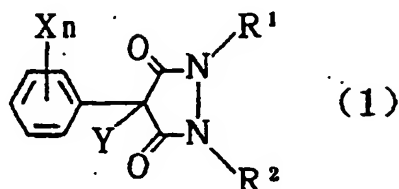
Compd.	amount (kg/ha)	treatment under submerged condition			
		Monochoria vaginalis var. plantaginea	Cyperus microiria Steud.	Echinochloa Crus-galli	Cyperus serotinus Rottb.
19	4	50	50	50	50
27	4	20	0	50	50
31	4	50	50	50	50

INDUSTRIAL APPLICABILITY

[0054] The compounds of the invention show high insecticidal and miticidal activities against many species of agricultural insect pests. Further, the compounds of the invention exhibit a high herbicidal activity against many species of weeds which would pose agricultural problems. Therefore, the compounds of the invention can provide useful formulations for control of harmful organisms.

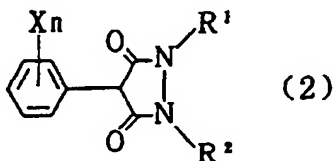
Claims

1. A 4-aryl-4-substituted pyrazolidine-3,5-dione derivative represented by the formula (1)

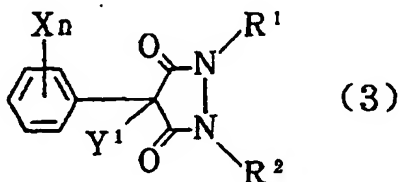


15 wherein R¹ and R² are each independently alkyl group having 1 to 4 carbon atoms, or R¹ and R², when taken together, represent saturated or unsaturated bivalent hydrocarbon group having 3 or 4 carbon atoms which may optionally be substituted with alkyl group having 1 to 4 carbon atoms, or halogen atom, X is alkyl group having 1 to 4 carbon atoms, haloalkyl group having 1 to 4 carbon atoms or halogen atom, Y is halogen atom or nitro group, and n is an integer of 0 to 3.

- 20 2. A 4-aryl-4-halopyrazolidine-3,5-dione derivative as defined in claim 1 wherein Y in the formula (1) is halogen atom.
3. A 4-aryl-4-nitropyrazolidine-3,5-dione derivative as defined in claim 1 wherein Y in the formula (1) is nitro group.
- 25 4. A process for preparing 4-aryl-4-halopyrazolidine-3,5-dione derivative comprising halogenating 4-aryl-pyrazolidine-3,5-dione derivative of the formula (2) to obtain 4-aryl-4-halopyrazolidine-3,5-dione derivative of the formula (3)



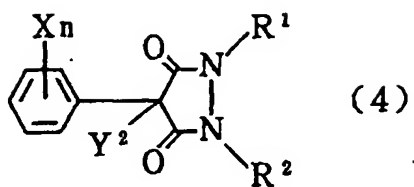
35 wherein R¹, R², X and n are as defined above



wherein R¹, R², X and n are as defined above, Y¹ is halogen atom.

- 50 5. A process for preparing 4-aryl-4-nitropyrazolidine-3,5-dione derivative comprising halogenating 4-aryl-pyrazolidine-3,5-dione derivative of the formula (2) to obtain 4-aryl-4-nitropyrazolidine-3,5-dione derivative of the formula (4)

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wherein R^1 , R^2 , X and n are as defined above, Y^2 is nitro group.

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6. A miticide, insecticide or herbicide comprising as an effective component at least one of 4-aryl-4-substituted pyrazolidine-3,5-dione derivative of claim 1.

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INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP98/04525

A. CLASSIFICATION OF SUBJECT MATTER Int.Cl. ⁶ C07D231/32, A01N43/56 According to International Patent Classification (IPC) or to both national classification and IPC		
B. FIELDS SEARCHED Minimum documentation searched (classification system followed by classification symbols) Int.Cl. ⁶ C07D231/32, A01N43/56 Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched Electronic data base consulted during the international search (name of data base and, where practicable, search terms used) REGISTRY (STN), WPI/L (QUESTEL)		
C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	JP, 8-269015, A (Mitsubishi Chemical Corp.), 15 October, 1996 (15. 10. 96) (Family: none)	1-6
Y	JP, 5-117240, A (Bayer AG.), 14 May, 1993 (14. 05. 93) & EP, 508126, A & US, 5332720, A	1-6
Y	JP, 6-506201, A (CIBA-Geigy AG.), 14 July, 1994 (14. 07. 94) & WO, 92/16510, A1 & EP, 577629, A & US, 5494890, A	1-6
Y	JP, 9-506341, A (E.I. Du Pont de Nemours & Co.), 24 June, 1997 (24. 06. 97) & EP, 729461, A & US, 5747516, A	1-6
<input type="checkbox"/> Further documents are listed in the continuation of Box C. <input type="checkbox"/> See patent family annex.		
* Special categories of cited documents: "A" document defining the general state of the art which is not considered to be of particular relevance "E" earlier document but published on or after the international filing date "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) "O" document referring to an oral disclosure, use, exhibition or other means "P" document published prior to the international filing date but later than the priority date claimed		"I" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art "&" document member of the same patent family
Date of the actual completion of the international search 16 December, 1998 (16. 12. 98)		Date of mailing of the international search report 19 January, 1999 (19. 01. 99)
Name and mailing address of the ISA/ Japanese Patent Office Facsimile No.		Authorized officer Telephone No.

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